PhD Synopsis

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1. Title of Synopsis

Studies on distribution and sources of arsenic and fluoride in geological, plant and biological samples of Ambagarh-Chowki block

2. Introduction

Arsenic is a toxic element and its intake causes cancer and harms the nervous systems, heart and blood vessels. People can be exposed to arsenic by inhaling it, by consuming contaminated foods, water, or beverages, or by skin contact. We are normally exposed to trace amounts of arsenic in the air and water, and in foods. Long-term exposure to arsenic at lower than toxic levels can lead to skin changes (darkening or discoloration, redness, swelling and hyperkeratosis (skin bumps that resemble corns or warts) [1-2]. Whitish lines (Mees' lines) may appear in the fingernails. Both sensory and motor nerve defects can develop. Additionally, liver and kidney function may be affected. Arsenic exposure over the long-term has also been associated with the development of certain cancers, and arsenic has been classified as a carcinogen by the Environmental Protection Agency (EPA). Studies of people in parts of Southeast Asia and South America where there has been a high level of arsenic in the drinking water have reported an increased risk of developing cancers of the bladder, kidney, lung, and skin.

The presence of elevated concentrations of As in groundwater in different regions of South Asia is of an increasing concern because a population of several million people is exposed to

inorganic As through drinking water, contaminated food, dust, etc. [3-13]. Also, various types of fluorosis diseases are reported in several parts of India [14-21]. The environment of Ambagarh Chowki, Rajnandgaon is contaminated with As and F^- at high levels [8-10]. Consumption of the contaminated water is the major pathway of As and F^- exposure for humans in this region.

3. Review

The problem of groundwater As contamination in the Chowki block situated in the Rajnandgaon district of the state of Chhattisgarh was first reported by Chakraborti et al. [22]. Groundwater samples from 146 sites, PHED tube wells and dug wells in 22 villages of this block were analyzed. Arsenic concentrations in tube well water samples were elevated above the WHO guideline by a factor of more than 10 with concentrations as high as 520 $\mu g\ l^{-1}$, whereas in the dug wells (general depth less than 50 m) As concentrations were as high as 880 $\mu g\ l^{-1}$ As. Medical study in that village indicated 42% of adults and 9% of children are suffering from arsenical skin lesions. Dermatological studies indicated high concentrations of As in urine (89%), hair (75%) and nails (91%) among the village population. In the same area, i.e. at village Koudikasa of Rajnandgaon district of Chhattisgarh, Central India, Pandey et al. [23] conducted an extensive study on the groundwater As over a period of three years (1998-2000) through systematic monitoring of As concentrations in hand pumps and dug wells in the region.

Arsenic contamination in groundwater at different concentration levels occurs as small patches in different parts of the Ambagarh-Chowki block of Rajnandgaon district of the state of Chhattisgarh in Central India. Tube well waters are affected by high concentrations of As in isolated and restricted areas that are confined to N-S trending Dongargarh-Kotri rift zone which exposes largely the early Proterozoic metavolcanic rocks and co-magmatic granite

[24].

In the Koudikasa block of Rajnandgaon district in Chhattisgarh state of India indicated elevated concentrations of As preferentially in the wells located in acid volcanic rocks, close to shear zones as well as in granites. Weathered rocks and soils are also enriched in As in severely contaminated areas. Arsenic preferentially occurs in iron-enriched soils and in altered biotite and chlorite in granite. Arsenic is sorbed in hydrated iron oxides (HFO) and in coatings on kaolinite, illite and goethite in soil or in coatings along cleavage traces on weathered biotite and chlorite. Reductive dissolution of HFO released sorbed As to groundwater along with Fe. Pyrite in volcanic and shear zone rocks, although locally As-bearing is a minor source in groundwater.

4. Objectives

The highest levels of As is present in the environment of Ambagarh-Chowki [8-11, 22-24]. In this region, the environment is also found to be contaminated with F^- [10]. Therefore, in the present work, the distribution of As and F^- in a variety of environmental samples will be carried. The objectives of the proposed work are:

- Distribution, variation and sources of As and F^- in geological samples i.e. water, soil, dust, sediment, etc.
- Accumulation pattern of As in plants i.e. rice, vegetables, leaves, grasses, etc.
- Distribution pattern of As and F^- in biological samples.
- Correlation of As and F^- with other ions and metals.

5. Noteworthy contribution in the field of proposed work

The distribution and speciation of As in the water, soil, rice and biological samples were reported by Patel et. Al [9, 25-26]. The F^- contamination of groundwater of this region at

elevated levels was reported [11]. The whole environment in this region is contaminated with toxic elements i.e. As, F^-, etc. enormously. This region of the country is a hot spot for further research to understand As and F^- toxicities.

6. Methodology

The environmental (water, soil, sediment, plant and urine) samples are collected using established methods [27-29]. The samples are cleaned with de-ionized water and digested by using microwave probe. The techniques i.e. HG-AAS, ICP-MS, etc. are used for As analysis. The ion-selective method is used for analysis of F^-. Ion chromatography is used for analysis of other ions. The ICP-AES technique is used for analysis of metals in the samples. The models i.e. factor analysis; multivariate analysis, etc. are used for source apportionment of As, F^- and other elements in environmental samples [30-33].

7. Outcomes of the proposed work

- Understanding of distribution pattern of As and F^- in geo-media.
- Understanding of accumulation pattern of As and F^- in plants and biological samples.
- Causes and sources of As and F^- health hazards.

8. Bibliography

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9. Publication

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(2) Source of arsenic and other elements in groundwater of Ambagarh Chowki, K. S. Patel, A. Bhatia, B. L. Sahu, R. K. Patel, M. Lautent, O. Sracek, P. Bhattacharya, and J. Hydrology, to be submitted.

(3) Distribution of arsenic in rhizospheric soil and plants, K. S. Patel, N. K. Jaiswal, A. Bhatia, B. L. Sahu, R. K. Patel, M. Lautent, Inter. Conf. Environ. Pollution, Restoration and Management, March 2013, Submitted.

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